



**Sandia
National
Laboratories**

Taking the Air Out of Respiratory Pandemics

**An R&D Effort for Developing New, Far Less Disruptive and
Frightening Protective Measures to Extinguish Airborne
Pathogen Outbreaks**

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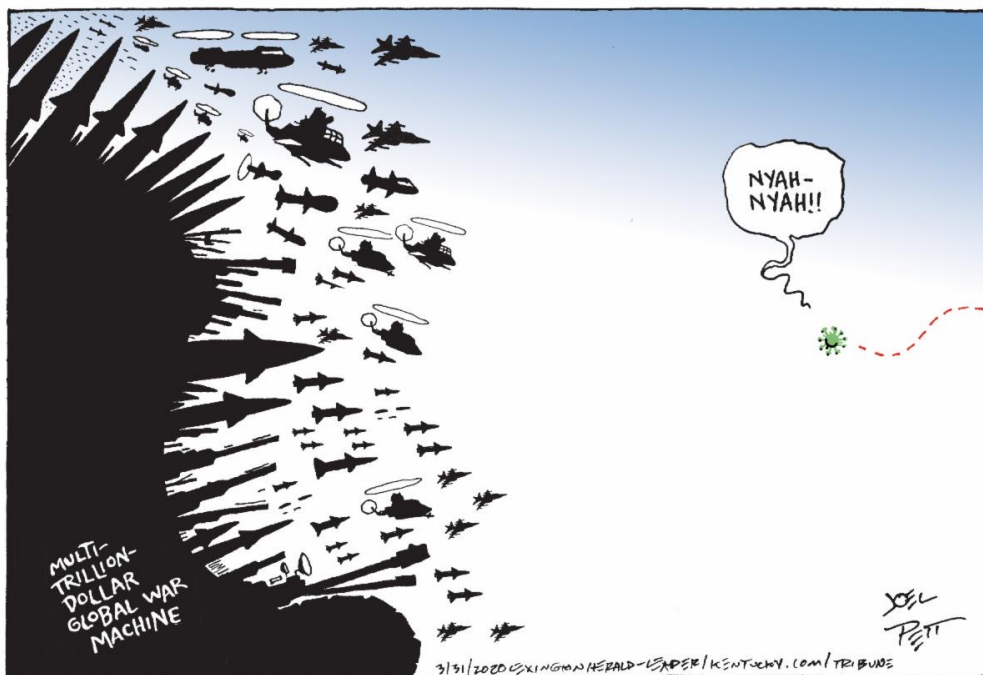
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Walter White from *Breaking Bad*
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Do you know someone who is as brilliant a cook as this former LANL chemist? If so, read on because this writeup is especially for chemists, biochemists, physicists, biophysicists, and device engineers who haven't broken bad.

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¹ Patrick D. Burton and Matt Tezak, “Variable Chain Length Carboxylic Acids as Modifiers to Enhance the Antiviral Efficacy of Sodium Dodecyl Sulfate,” Sandia National Laboratories, SAND2020-5940, June 10, 2020, pp. 1-26.

² “Nasal Delivery of Antiseptics and Related Research Topics,” Preliminary Research Journal, Perspectives, Inc., July 2020, pp. 1-10.

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COMING UP WITH BETTER WAYS TO PROTECT PEOPLE FROM LIFE-THREATENING PATHOGENS

We are in the midst of a pandemic that continues to spread where people are afraid not only of the SARS-CoV-2 virus, but also of the disruptive and fear inducing side effects associated with the public health measures that have been put into place. While Newton's Laws of Motion provide the scientific basis for the effectiveness of face masking, social distancing, and self-isolating to curtail viral spread, these physics-based approaches are pretty much the same as those taken 100 years ago when nobody even knew what a virus was.

Given our collective understanding of pathogens and infectious diseases, as well as our demonstrated abilities to innovate, there ought to be better, more modern ways to snuff out an outbreak. Just as we have fire extinguishers and sprinkler systems to put out small fires and prevent raging infernos, we need readily available devices and easily adoptable techniques that can protect people from new, airborne pathogens well before disease spread reaches epidemic proportions and without the fear factor and socio-economic upheaval that's inherent in early 20th century public health measures. To figure out what those better ways are *and* put them into practice, we have to answer four pointed questions that go to the heart of what turns an initial respiratory outbreak into a global pandemic.³

1. Prior to gathering with other people or going to bed, can individuals spray an over-the-counter, non-toxic chemistry into their nose, mouth, throat, or even their lungs to form a protective barrier against respiratory infection *and* entomb any exhaled pathogens inside an aerosol shell, rendering them harmless to others?
2. As part of a daily hygiene regimen or upon the early onset of known symptoms, can individuals do something analogous to toothbrushing to keep their nose, mouth, throat, and lungs clean and free of respiratory infection?
3. Can the air inside our homes, schools, and businesses be circulated and purified in a way that's effective and visibly reassuring to the building occupants?
4. Are there novel physics-based approaches that could be developed to hold respiratory pathogens at bay without face masks, social distancing, and self-isolation?

If these four questions can be answered affirmatively and adopted using specific chemical, biochemical, physical, and/or biophysical measures, it's possible the number of new disease infections per actual human infection could be brought down to less than one (i.e., $R_0 < 1$). In doing this, the present and all kinds of future respiratory pandemics and infectious biological attacks could be extinguished, without mass fear and disruption, well before an effective vaccine or hospital treatment is developed and validated.⁴

³ These four questions are derived from the seven core pandemic problems described in [Vipin P. Gupta and Kenneth R. Miller, "Doing Pandemic R&D as if There's No Mañana," Sandia National Laboratories, SAND2020-4667O, April 23, 2020, p. 5.](#)

⁴ In addition to directly tackling respiratory disease outbreaks, these approaches could improve the health and well-being of people more generally.

PROTECTING THE NOSE, MOUTH, THROAT, AND LUNGS

Literally and figuratively, the nose, mouth, throat, and bronchial tubes are the chokepoints for airborne pathogens. If infectious, microscopic particles are intercepted, immobilized, and neutralized within these respiratory interfaces with the outside world, disease spread could be contained without sparking the exponential growth trajectories that portions of the country and world are currently experiencing. There are two ways to do this: by preventing the pathogen from establishing a beachhead inside a person's respiratory system⁵ and by encapsulating exhaled infectious pathogens inside a droplet or aerosol shell that also contains anti-pathogen compounds capable of either gumming up the physical features the pathogen uses to invade human cells (e.g., the coronavirus spikes) or eating away at the exhaled pathogen itself while it's airborne.

For decades, there have been mass markets for over-the-counter devices that deliver chemistries into our nasal cavities, mouth, throat, and lungs that either increase pleasure or decrease pain: breath fresheners, nasal sprays, sore throat soothers, bronchial dilators, and vaping products (see Figure 1). What we lack is a variety of anti-pathogen concoctions and intuitive user instructions that could be put into these well-established delivery devices that are already being manufactured, distributed, and used on a national and global scale.



Figure 1: Common consumer products that deliver chemistries into the human respiratory system.

Already, there are several known ingredients that could provide the potency within anti-pathogen formulations for protecting these respiratory chokepoints: zinc, iodine, salt, colloidal silver, coconut oil, alcohol compounds, and acidic compounds.⁶ From these and other yet-to-be-tried active ingredients, we could develop at least four types of protective formulations:

1. One to spray just before joining a group of others (e.g., work, a social gathering, sports event, a crowd filled with strangers).
2. One designed specifically for protecting those with underlying conditions (e.g., high blood pressure, diabetes, etc.).
3. One with a taste that caters to a child's palette.
4. One that's more potent for use over a finite period of time immediately after experiencing early possible symptoms or receiving a positive test result (e.g., the equivalent of a cold remedy or preventative taken just before going to bed).

⁵ According to the scientists at the UNC Gillings School of Global Public Health and the UNC School of Medicine, the SARS-CoV-2 virus "tends to become firmly established first in the nasal cavity." From there, it can aspirate into the lungs, particularly while the infected person is asleep, causing a more serious and sometimes life-threatening disease. Yixuan J. Hou et al, "SARS-CoV-2 Reverse Genetics Reveals a Variable Infection Gradient in the Respiratory Tract," *Cell*, May 26, 2020. DOI: <https://doi.org/10.1016/j.cell.2020.05.042>

⁶ Medical practitioners are also trying inhalers with corticosteroids or new biochemistries to protect the lungs from infection. See literature review cited in ref. 2.



Figure 2: Conceptual public health signage that's messaged to the cognitive state and circumstances of particular audiences with access to anti-pathogen sprays for protecting themselves and others around them.

If these types of safe chemistries are developed, tested, and validated, it could transform public health worldwide (see Figure 2). People would have the wherewithal in their pockets, purses, and medicine cabinets to protect themselves and would gain a measure of reassurance that they were not unknowingly spreading a dangerous disease. As importantly, societies would have a safe way to operate day-to-day with the human densities and socio-economic activities of modern life.

NEW HYGIENE REGIMENS

While toothbrushing and mouthwashing are commonplace as a once- or twice-a-day anti-pathogen hygiene activity,⁷ we lack new and effective regimens to keep our noses, mouths, throats, and lungs clear of contagious infection. Beyond the use of tissues to blow our noses, soap to wash our hands, and covered coughing when clearing our throats, we haven't put enough thought and effort into developing and testing liquid, aerosol, chewable, and dissolvable formulations that people would be willing to adopt as a preventative measure during an outbreak. The trick associated with these types of hygiene measures is developing delivery techniques that don't trigger the sneeze or gag reflex and don't produce a mess that can't be easily disposed inside a tissue or rinsed down a drain.

⁷ [Alexandra Thompson, "Coronavirus: Scientists want to investigate if mouthwash kills the infection," Yahoo!Life, May 14, 2020.](#)

In some parts of the world, tongue cleaning and nasal rinsing are already routine hygiene activities using tools as simple as a strip of virus-unfriendly copper or a spouted pot. Given how the SARS-CoV-2 virus uses our nasal cavities and throat area to establish itself and is consequently able to use asymptomatic people as carriers for further spread, it's worth revisiting and modernizing these hygiene practices—particularly within cultures where these cleansing techniques are not known or considered off-putting. In the recent history of infectious diseases, we already know that habit forming hygiene can have a major impact on disease prevention. What we lack today is the knowledge, recommendations, and technical means to enable the public to make changes in their daily cleansing routines that'll definitively curtail respiratory spread.

CLEARING THE AIR

The indoors shelters us from the elements and enables us to set temperature, humidity, air flow, and lighting conditions that we individually and collectively deem comfortable and conducive for work, rest, and play. The COVID-19 pandemic has revealed a gaping omission in the design and function of our shared indoor spaces. In our collective, decades long efforts to remove pollutants from outdoor air, we haven't paid enough attention to the introduction and circulation of dangerous pathogens in indoor air.⁸

In addition to modifying our heating, ventilation and air conditioning (HVAC) systems to bring in fresh air, filter circulating air, and vigorously clean indoor air whether or not anyone is present, there is a need for air purification systems that handle not only room air, but also localized air around individual work spaces, desk areas, and tables for socializing. Like room or ceiling fans,⁹ these units need to be easy to maintain and operate in a highly visible way with filtration, chemical disinfection, and/or ultraviolet illumination and have the equivalent of Underwriters Laboratories (UL) certification against airborne pathogens. In addition, open source, indoor air flow models are needed to validate the effective, deployed distribution of these units within specific buildings. Just as fire suppression and indoor sprinkler systems are explicitly written into building codes, an equivalent set of public health codes and standards are needed for killing or expelling airborne pathogens in our schools, workplaces, restaurants, gyms, and theaters. Many individuals and indoor spaces already have the ability to control odors and circulate pleasant scents using air fresheners and scented diffusers. These existing aerosol products now need to be notched up with anti-pathogen capabilities to enable the congregation of people while dramatically reducing the risk and frequency of super-spreader events.

⁸ More than half of a person's air intake over a lifetime comes from indoors. J. Sundell, "On the History of Indoor Air Quality and Health," *Indoor Air*, vol. 14, 2004. DOI: 10.1111/j.1600-0668.2004.00273.x

⁹ Like breezes and wind outdoors, room, workspace, and personal fans have a role to play in deflecting, dispersing, and expelling indoor airborne pathogens. Developing practical ways to effectively use these common devices is something that's also badly needed.

BIOPHYSICAL INTERVENTIONS

Just as Continuous Positive Airway Pressure (CPAP) machines are a biophysical remedy for sleep apnea, there are numerous biophysical concepts that have yet to be realized for countering airborne pathogens. These span from the use of biological markers to make exhaled pathogens emit or reflect light to the introduction of an electrical charge or magnetic material into the pathogen's cell structure so that its airborne trajectory can be altered by generated fields from new types of appliances deployed in rooms and wearables worn on our heads or around our necks.¹⁰ Given that respiratory pathogens need human airways and human cells to multiply themselves, biophysical interventions can take advantage of this reproduction process to alter successive generations of the pathogen. In doing so, we can stop being passive carriers and propagators of the pathogen and proactively give it properties that'll enable us to see it, smell it, taste it, divert it, or poison it by planting a microscopic antiviral into its cellular features.

TAKING THE DEAD AND THE DREAD OUT OF DISEASE OUTBREAKS

The key to getting a grip on this and future respiratory disease outbreaks is to have the ability to extinguish them *before* they turn into pandemics. As important is the need for 21st century protective measures that don't have the fear factor and socio-economic disruption associated with face masking, social distancing, and self-isolation, as well as the lag time that's inherent in vaccine development and medical treatments. Just as quantum physicists were the ones with the scientific knowledge that was needed to make nuclear deterrence possible as a world war preventative, chemists, biochemists, physicists, biophysicists, and device engineers are well equipped to eradicate respiratory pandemics altogether. With new antiseptic formulations and disinfection methods to clean what we breathe in and protect the narrow passages we breathe through, global society can get to the other side of this pandemic and have the wherewithal to deny future respiratory outbreaks the safe airborne passage that pandemics need to spread like wildfire. In this kind of evolved world, our extraordinary personal and global interactions can be restored once again and for the foreseeable future with everyone able to breathe and touch without fear.

¹⁰ The SARS-CoV-2 coronavirus uses an electrostatic force to attach itself to a host cell. Considering the history of wearing garlic garlands in an attempt to keep away the plague, it's worth exploring and validating new deflection and interception methods that don't rely on the wearing of surgical masks or medieval bird beaks that obscure our faces.